CALIFORNIA DIVISION OF MINES AND GEOLOGY

Supplement no. 2 to Fault Evaluation Report FER-42

April 24, 1978

1. Unnamed fault in West Coyote Hills.

4. <u>Additional references:</u>

California Division of Oil and Gas, Annual Reports of the State Oil and Gas Supervisor 1965-1976 (production and water injection data).

Converse, Davis and Associates, 1970a, Preliminary fault study, Standard Oil property south of Idaho Street and Imperial Highway, La Habra, California: Unpublished consulting report of August 13, 1970, for John D. Lusk and Sons, 12 p., 1 map (scale 1 inch = 100 feet).

Converse, Davis and Associates, 1970b, Supplemental fault study, Standard Oil Company property and Tract no. 5630, La Habra, California: Unpublished consulting report of October 22, 1970 for Country Hills, Inc., 6 pages, 7 plates.

Leighton and Associates, 1973 (?), City of La Habra Seismic Safety Element, 34 p., plate 2 (geologic/hazards map showing faults classified as active and potentially active).

Mefferd, M.G., and Cordova, S., 1962, West Coyote Oil field: California Division of Oil and Gas, Forty-eighth Annual Report, p. 37-46, 9 plates (only one significant fault is shown and this trends N 20° E, dips steeply west, has 300-400 feet of dip-slip with W side up, and lies nearly 1/2 a mile west of surface fractures).

Note: Another active fault was reported 2 mi to W? 1 mi S. of ... small unnamed flt in Coyote Hills ... in Coyote Hills ... formed after 3.5 M E/Q ... Bitela, Rig Park nr Beach & Rosecrans (Jeff ... Orange Co. geol, p.c., 3/19/85) -- EWH

5. Summary of available data:

Based on the data and recommendations presented in FER-13 (dated November 30, 1977, p. 9-12), the unnamed active fault in the West Coyote Hills was evaluated further. According to Converse, Davis and Associates (1970a), the ground cracks associated with faulting were first reported in October 1968 and mapped by geologists from Standard Oil Company. The location of the fracture zones are shown in detail on Drawing no. 1 of that report. As observed in 1970, the ground cracks were described (p. 3-5) as occurring discontinuously as 3 sets of fissure over a length of 250 feet where the crack zone crosses the paved access road (Locality 1 on figure 5). Although a maximum of 2 3/4 inches of vertical displacement (east side up) was noted at the road, the cracks commonly appear as open fissures, often associated with "trough-like features" and "aligned depressions" as much as 2.5 feet wide. The depressions are attributed to settlement into the open fissures. Additional minor cracking was noted along the road in fill about 550 feet to the north (Locality 4 on figure 5). All of these cracks are in slope wash or alluvium, which overlies sandstone units of the San Pedro Formation (Pleistocene). The latter dips consistently to the north between 3 and 17 degrees. The reported cracks coincide with the short north-trending fault mapped by Yerkes (1972). Other faults also were mapped in the area by Converse, Davis and Associates (p. 7 and Drawing no. 1). All of the faults were considered to be relatively minor and related to "anticlinal folding when the Coyote Hills were formed ..."

Subsequent trenching by Converse, Davis and Associates (1970b) revealed the location and nature of the ground cracks more clearly.

Typically, the 1968 fractures were open fissures that overlay bedrock faults (e.g. see figure 6). The open fissures are nearly vertical, coincide with the mapped ground fractures, and indicate extensional opening in trenches TR-1 to TR-4. The underlying bedrock faults in trenches TR-1 and TR-2 mainly dip steeply to the west. Bedrock (Pleistocene) faults also were identified in TR-7 to TR-10, but no historic fractures were reported. In TR-7, the fault zone is 4.5 feet wide, diminishing to a series of minor shears in TR-10. The consultant speculates that fault "A" joins fault "B" 400 feet to the north. The description of the 1968 ground ruptures by Yerkes (1972, p. C31) contrasts somewhat with the above in that Yerkes observed evidence of an east-dipping reverse fault with a component of left-lateral movement (right-stepping fractures). Converse, David and Associates (1970a, 1970b) clearly identified open fractures above ~~with~~ a pre-existing west-dipping to vertical fault.

Fault "B" also was investigated and mapped by Converse, Davis and Associates (1970b). This fault (see figure 5) cuts the Coyote Hills Formation (Pleistocene age) but reportedly does not offset the overlying soil and slopewash deposits. No further information (e.g. amount, sense and geometry of offset) is provided by this reference. The fault aligns with a fault mapped to the southeast by Yerkes (1972, plate 1), but it is not shown to connect with it. Yerkes and Converse, Davis and Associates both show other faults of Quaternary age in the West Coyote Hills (figure 5 herein and figure 4c in FER-42).

Converse, Davis and Associates (1970b, p. 5) concluded the following:

1) The 1968 surface rupture is the result of displacement along Fault "A".

2) Fault "A" probably is not related to deep seated crustal (tectonic) movements" but is probably due to a) ground subsidence related to oil field fluid withdrawal or b) anticlinal growth. (Note: Both of these may play a role, as large-scale fluid withdrawal and water injection has been conducted for many years in the West Coyote oilfield (California Division of Oil and Gas.) This has resulted in net withdrawals prior to 1966 and since 1974. However, water injection exceeded oil and water withdrawal by as much as 7,900,000 barrels from 1967 to 1973, peaking in 1969. Also, there is no known macro-seismicity associated with the oil field area or with the time of the ground fracturing.

Bob Erickson of Standard Oil Company of California, operator of the West Coyote Oilfield, also was contacted with regard to the 1968 ground ruptures (p.c. 2/21/78). According to him, ground displacement and cracking continued for a few weeks during October then ceased. He verified the nature and magnitude of ground rupture reported by Yerkes and Converse, Davis. He indicated that other historically active faults are not known in the West Coyote Hills. Erickson stated that the West Coyote Hills has become a "positive area" since pressurization (i.e. water flooding) of the oil field, but he did not speculate as to the cause of the ground ruptures.

Fault "A" is classified as active by the City of La Habra in their Seismic Safety element. Other faults, including fault "B", in the west Coyote Hills are classified as potentially active on the basis of their offsetting Pleistocene units. A discussion of the active and potentially active faults is given by Leighton and Associates (1973).

7. Field observations:

The site of the ground ruptures was examined by the writer and by Drew Smith on 2/28/78 and no evidence of historic ground deformation was observed along or adjacent to the access road. However, nine years had elapsed since ground rupture had occurred. Also, we did not have benefit of the detailed maps of Converse, Davis (1970a and b) at that time.

8. Conclusions:

The ground fractures of 1968 and subsequent trenching and mapping of Converse, Davis (1970b) demonstrate that an active fault exists from locality 1 to trench TR-4 (see figure 5). Moreover, there is evidence that the fault is traceable in Pleistocene rocks as far north as TR-10 and for 500 feet south of locality 1. This is designated as Fault "A" and is shown as a green dashed line on figure 5. Although the fault appears to be a relatively minor fault-rupture hazard (a maximum of 3 inches of offset was reported in 1968), the fault is well-located and should be readily avoidable. It is probable that faulting was caused by oil field operations. The fault may connect with other Quaternary faults in the area (e.g. Yerkes, 1972, plate 1), but there is no reported evidence of Holocene activity for these other faults. [redacted].

Fault "B" (figure 5) is considered to be potentially active as are other faults that offset Pleistocene units in the West Coyote Hills. Such faults are fairly abundant and are apparently minor, as they are not identified at depth even though the West Coyote Oil field is developed by more than 300 wells which provide good stratigraphic control (Mefferd and Cordova, 1962).

9. Recommendations:

Only Fault "A" meets the criteria of "sufficiently active and well-defined" to warrant zoning under the Alquist-Priolo Special Studies Zones Act. It is recommended that only that portion of Fault A shown by a green dashed line on figure 5 be zoned. The zone should be drawn as narrow as feasible, as the fault has been accurately located by trenching. Fault "B" should not be zoned as 1) there is no evidence that it has been active during the Holocene and 2) only a short segment of the fault is well-defined (i.e. locatable in the field).

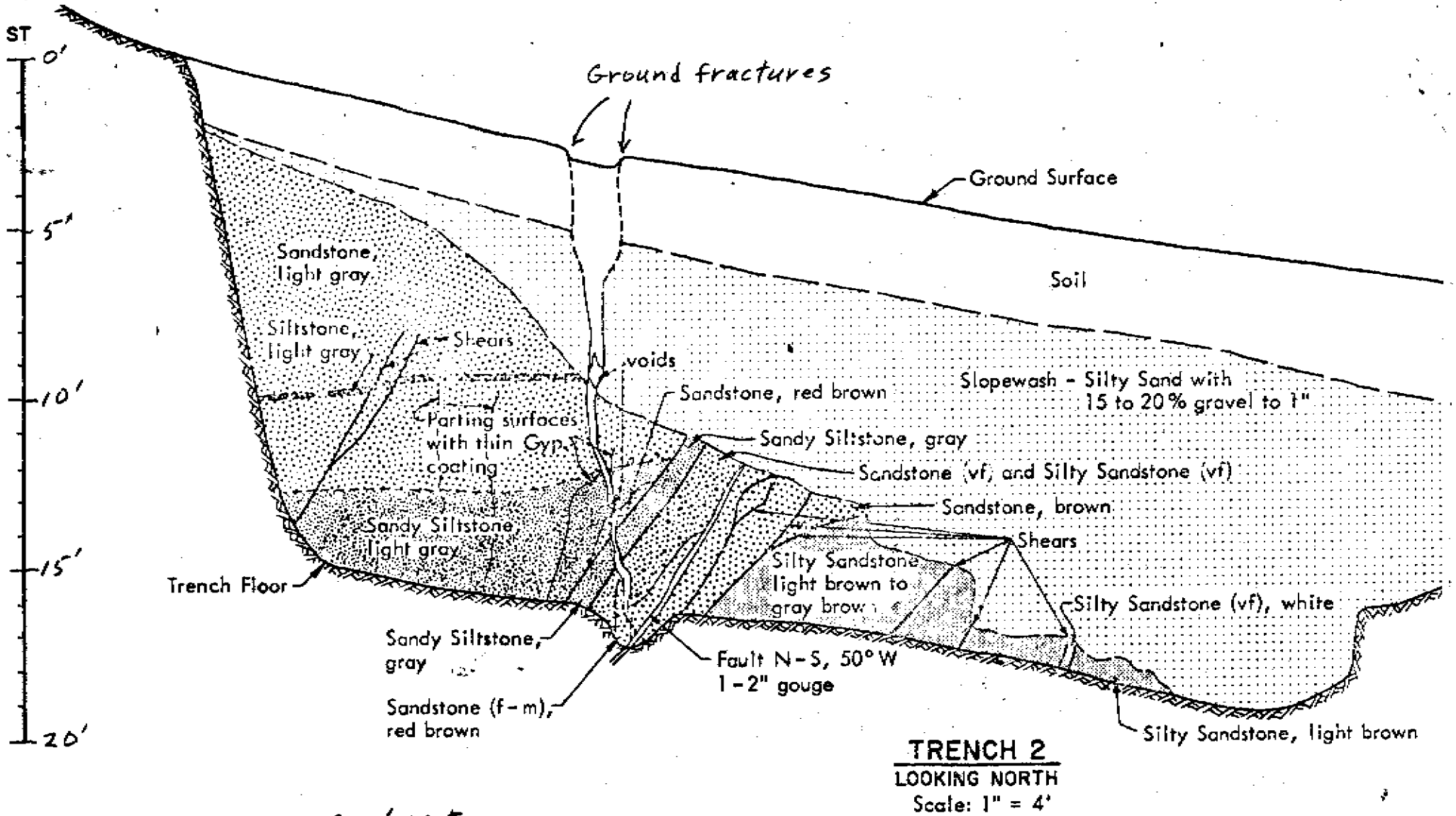
10. Report prepared by: E.W. Hart, 4/26/78.

Earl W. Hart

I agree with your observations, conclusions, and recommendations

Drew

5-1-78



supplement

Figure 6 (FER-42) — Log of trench 2 (see Fig. 5 for location) showing relationship between ground fractures and bedrock fault (from Converse, Davis & Assoc., 1970b).

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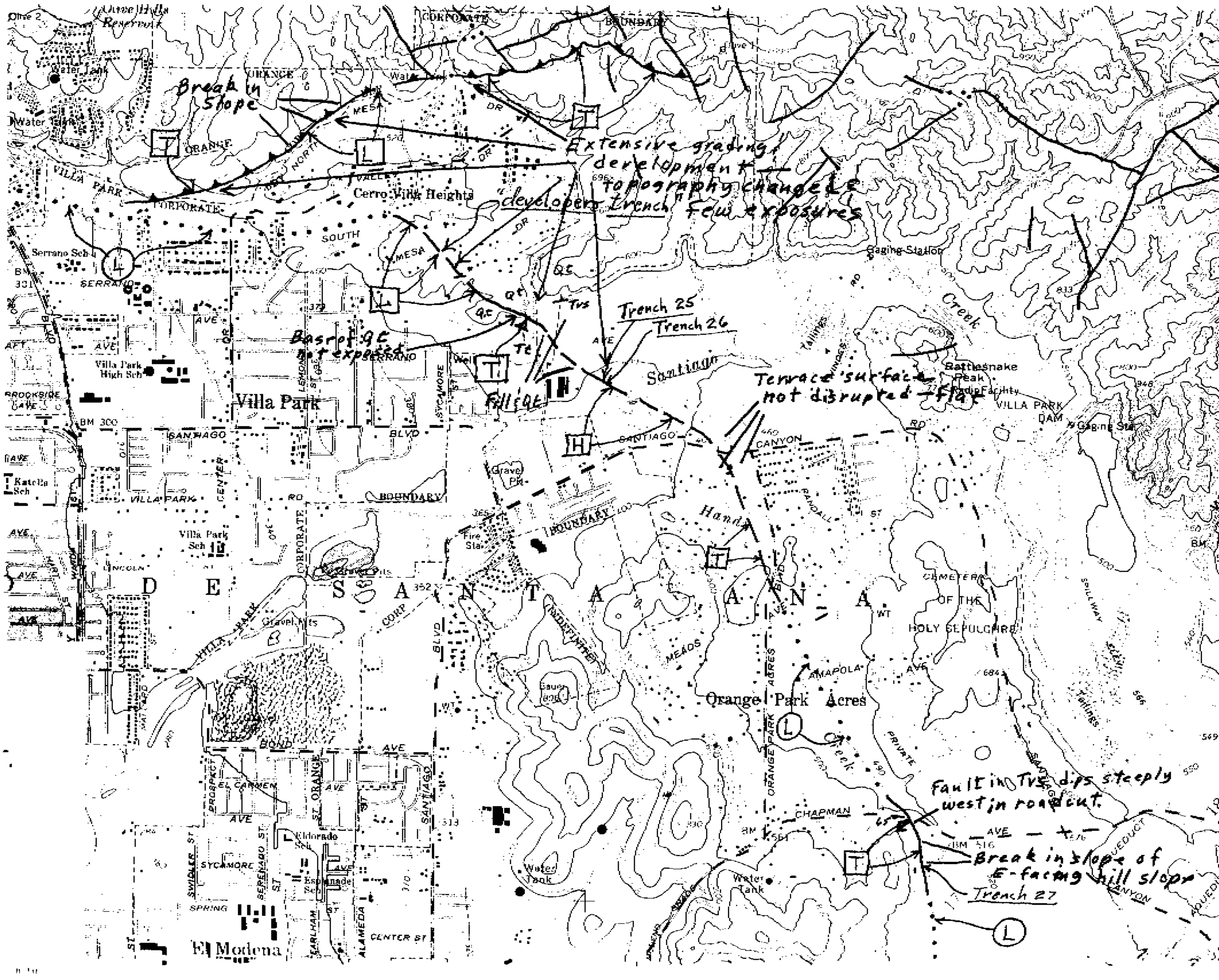
CHECKED BY: JDS	
APPROVED BY:	DATE: Sept. 18, 197

CONVERSE DAVIS AND ASSO



Modified from FER-42, Fig. 4c (D. Smith, 1977)